



CDR DEVELOPMENT PROJECT

**Development of new 3-hourly, global, long-term,
multisatellite-based TOA-to-surface
radiative flux profile data product with
high horizontal resolution and homogeneous quality**

PI: Yuanchong Zhang¹

CO-I's: Andrew A. Lacis², William B. Rossow³ and Valdar Oinas⁴

**Columbia University¹, NASA GISS², The City College of New York³
and Trinnovim, LLC⁴**

Tel. (212)678-5514; Email yz7@columbia.edu

Outline

- Project Description
- Production and QA Approach
- Applications
- Schedule & Issues

<<Warning: Presentations are limited to 15 minutes each (incl. 1-2 Q&As). Due to the number of speakers, this must be strictly enforced!>>

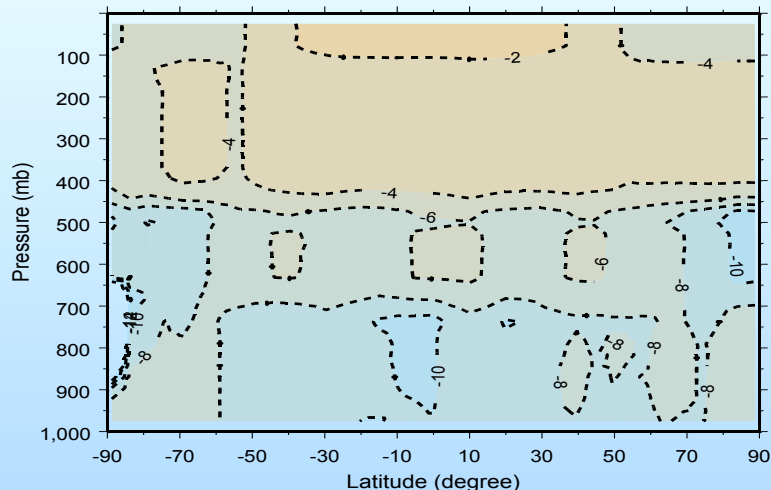
Project Description (I)

- **CDR Product:** ISCCP-FH
 - Global, 3-hrly, long-term radiative transfer SW and LW flux profile data product based on radiative transfer model, RadH, an improved model of the current NASA GISS RadE of GCM ModelE — a new, improved version of the current ISCCP-FD.

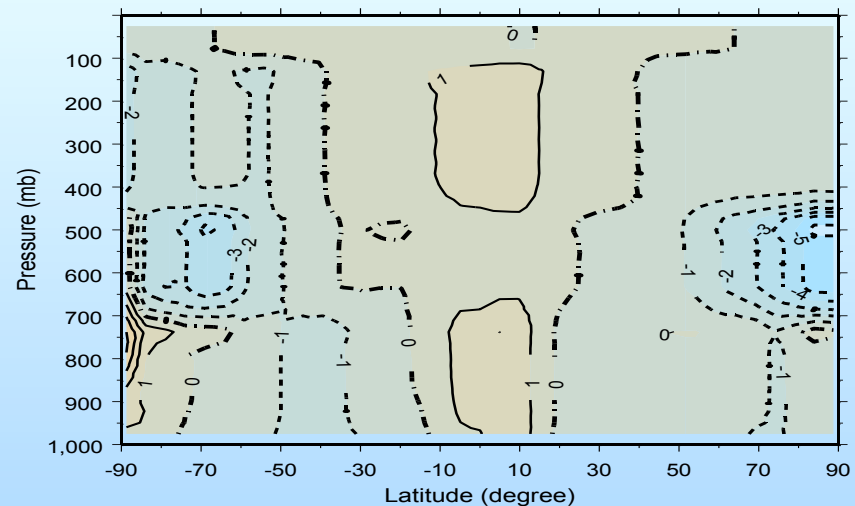
Examples:

Vertical Profile of total zonal radiative divergence and its cloud effects

85-89 Mean Total (SW+LW) Divergence in Atmosphere (W/m^2)



85-89 Mean CE for Total (SW+LW) Divergence in Atmosphere (W/m^2)



Project Description (II, continued)

Inputs:

- ◆ ISCCP H- series (High resolution), 3-hourly cloud climatology product with ancillary datasets for temperature & humidity profile, ozone and surface properties (land/ocean mask, topography, snow/ice, vegetation, albedo, etc.)
- ◆ Gases: Climatology with trends (in RadE, except O₃ & H₂O)
- ◆ Aerosols: New 6-band HACv1 (The Hamburg Aerosol Climatology version 1) based on AeroCom to replace RadE' s

Outputs:

- ◆ Flux profile of all upwelling and downwelling, all-, clear- and overcast-sky, broadband SW (0.2-5 μm) and LW (5-200 μm) at designated vertical atmospheric levels from TOA to Surface
- ◆ Collateral product: all input datasets used in flux calculation
- ◆ Temporal resolution: 3-hourly
- ◆ horizontal resolution: $\sim 100\text{km}$
- ◆ vertical resolution: $\sim 100\text{ hPa}$ (the current ISCCP-FD has 5 levels at TOA, 100, 440 and 680 hPa, and Surface)
- ◆ Spatial/temporal coverage: full-global/1983–2012
- ◆ Format: Binary and NetCDF

Project Description

CDR(s)	Period of Record and Temporal Resolution	Spatial Resolution & Projection Used (if applicable)	Update Frequency	Data file distinction criteria	Inputs	Uncertainty Estimates (in percent or error)	Collateral Products (unofficial or unvalidated & produced alongside)
ISCCP-FH	1983-2012 3-hrly	horizontal ~100km Equal-area (1°X 1° available) and vertical 100 mb	Extended as ISCCP and other ancillary data	Subdataset name and 3-hrly UTC, date, month and year	ISCCP H-series cloud product and ancillary datasets from ISCCP and other sources (e.g., O3, surface spectral albedo)	Possible reduction of 2-5 W/m ² from current 5-10 W/m ² at TOA and 3-7 W/m ² from current 10-15/m ² at Surface for monthly/regional (instantaneous and regional will have larger uncertainties)	All the input datasets used in flux calculation

Production Approach (I)

1. New radiative transfer model RadH is improved from RadE with:
 - (1) Increasing LW precision by revising 33 k' 's in correlated k-distribution algorithm, especially for water continuum bands
 - (2) Adding new SW absorptivity for gases (CH_4 , N_2O and H_2O continuum, etc.)
 - (3) Employing a new microphysical ice cloud model, if available.
2. New input datasets are also improved with
 - (1) Better and high-resolution, 3-hourly cloud climatology
 - (2) Better and more homogeneous HIRS temperature-humidity profile
 - (3) Better aerosol climatology (HACv1 based on AeroCom)
 - (4) Better surface properties (albedo, emissivity and snow/ice...)
 - (5) Better Cloud Vertical Structure (CVS) model

Validation & Quality Assurance (I)

1. Validation and determination of precision and uncertainty:

(1) Radiative model (RadH): against the line-by-line flux results

(2) ISCCP-FH product:

- ◆ TOA fluxes: with more direct TOA flux measurements, e.g., ERBE, CERES, NPP-ERB and JPSS (if possible)
- ◆ Surface fluxes : with direct surface flux measurements, mainly BSRN
- ◆ Atmospheric flux profile: with CloudSat/CALIPSO, ARM BBHRP, CIRC line-by-line results and CALIPSO, CloudSat, CERES, and MODIS merged product (CCCM) upon their availability
- (3) Input datasets: will be evaluated by ISCCP, FH and GEWEX

Validation & Quality Assurance (II, continued)

2. Various statistical analysis will be used for
 - (1) Evaluation against actual or near-actual measurements in means at TOA and Surface for global, regional and station-defined grid-cells for different times (3-hrly, daily, monthly, and decades-long) as done in the GEWEX Assessment for ISCCP-FD
 - (2) Comparison with other model products (GEWEX-SRB, ECMWF, NCEP...)
 - (3) Mutual evaluation between FH and surface observations using meteorological similarity comparison method (MSCM) to pre-sorting for more accurate evaluation
4. More comprehensive evaluation like what we have done in our previous work in our (at least) eight papers and GEWEX Radiation Flux Assessment for ISCCP-FD and other flux products .
5. If correctable problems are identified from these evaluations, the corrections will be used to reprocess ISCCP-FH products
6. Target precision:
Reducing the flux uncertainties by 2–5 W/m² from 5–10 W/m² at TOA and by 3–7 W/m² from 10–15 W/m² at the surface in monthly/regional means

Uses & Applications (I)

As ISCCP-FH incorporates abundant climatological information of

(1) all the flux components under all the scenes for global, vertical profile from TOA to surface in 3-hrly over ~30 years, and

(2) all the atmospheric and surface physical properties that produce their determined radiative transfer fluxes of (1), including aerosols and clouds,

it is expected to have various practical applications and lead to possible key scientific findings.

▪ Applications and Uses

1. Supplying high-resolution surface solar energy estimates for solar power industries to optimize their deployment of solar panels and grid system in order to increase renewable energy portion of all kinds of energy sources.
2. Supplying long-term daylight duration estimate for agriculture development, aquatic farming and exploration of ocean resources.
3. Supplying thermal energy estimates (in additional surface air and skin temperature) for urban heating/cooling system planning as policy makers need.

Uses & Applications (II, continued)

4. When used to produce water and land surface latent + sensible heat flux (e.g., WHOI routinely use ISCCP-FD to do so), it would be useful for optimizing uses of land and ocean resources.
5. Possible long-term tendencies of surface warming/cooling may help policy makers to make advanced planning for human habitation and planting migration.

■Key Scientific Findings

1. Helping diagnose and identify radiative cause-and-effects for the total atmosphere-earth system and its various individual constituents, and their variations – also useful for policy makers to understand how radiative energy is related our everyday life.
2. Helping Investigate and quantify cloud-radiative feedbacks — the largest uncertainty for climate forecasts, which requires atmospheric heating/cooling rates that ISCCP-FH can supply.
3. Providing quantitatively accurate determinations of radiative flux profiles to evaluate weather forecast model representations of weather-related and seasonal variations and climate forecast model representations of seasonal-to-interannual variations.

Schedule & Issues (I)

- Accomplishments over past and project status

Tasks		Personnel responsible	YEAR 1 1108-1207				YEAR 2 1208-1307				YEAR 3 1308-1407			
1	Creation of new production codes:													
	(1) Extract and make runnable→Rad-ModelE-0	Lacis; Oinas	✓	✓										
	(2) Improving Rad-ModelE-0 →Rad-ModelE-1	Lacis; Oinas	✓	✓	✓	✓	✓	X						
	(3) Modify and generalize Rad-ModelE-1	Zhang; Lacis			✓			X						
2	New product processing													
	(1) Make all input datasets available	Rossow; Zhang	✓	✓	✓	X								
	(2) Create new ingestion codes	Zhang			✓	✓	X							
	(3) Production	Zhang							✓	X	X	X	X	
3	Reengineering all the codes	Rossow; Zhang		✓	✓	✓	✓	✓	X					
4	Evaluation of new codes and products	All	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X

Where, X = Originally planned, either being done or not yet done at all

✓ = Finished as originally planned

1108=2011 August, etc. in YYMM (year + month)

Schedule & Issues (II, continued)

- ◆ New improved Cloud Vertical Structure (CVS) Model for high and middle clouds (as ISCCP defined)
- Based on 3-yr climatology from **matched** CloudSat & CALIPSO (C&C) CVS and Cloud Optical Thickness (τ)
- Function of τ and Cloud Top Pressure (PC in 5 ranges) with 1st and 2nd largest Relative Frequency Occurrence (RFO) for 7 climate zones (ocean and land separated) for each month (cf. Previous universal 6-range τ and 2-range PC determined CVS model for all time and regions as shown for matched DX on left column)

